Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

A280.39
R31A
Cop. 2

June 1967

ARS 51-12

EFFECT OF LOAD PATTERN ON TRANSIT TEMPERATURES AND CRUSHING OF LETTUCE IN TRANSCONTINENTAL SHIPMENTS

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JUL 10 1967
CURRENT SERIAL RECORDS

U. S. DEPARTMENT OF AGRICULTURE

Agricultural Research Service

ACKNOWLEDGMENTS

The cooperation and assistance of the following organizations, firms, and persons are gratefully acknowledged:

Shippers providing test cars or test packages or both of lettuce:

Admiral Packing Co., Salinas, Calif.
Bud Antle, Inc., Salinas, Calif.
Bruce Church, Inc., Salinas, Calif.
Harden Farms of California, Inc., Salinas, Calif.
Mutual Vegetable Sales, Salinas, Calif.
P and R Brokerage Co., Salinas, Calif.
Salinas Lettuce Farmers Coop., Salinas, Calif.
Salinas Valley Vegetable Exchange, Salinas, Calif.
Sears Bros. & Co., Salinas, Calif.

Vacuum cooling companies for loading cars and trailers in the desired loading patterns:

Bud Antle, Inc., Salinas, Calif.
Frigi-vac Co., Salinas, Calif.
Growers Vacuum Cool Co., Salinas, Calif.
Salinas Cooling Co., Salinas, Calif.
Union Ice Co., Salinas, Calif.

Carriers providing equipment for test shipments:

Pacific Fruit Express Co., San Francisco, Calif.
Western Pacific Railroad Co., San Francisco, Calif.

Persons assisting in arranging and loading or receiving and evaluating test shipments:

Roy Scott, Harden Farms of California, Inc., Salinas, Calif.
Howard W. Hruschka, U.S. Department of Agriculture, Beltsville, Md.
Walter Redit, USDA, Beltsville, Md.
Michael Garazsi, USDA, Fresno, Calif.

EFFECT OF LOAD PATTERN ON TRANSIT TEMPERATURES AND CRUSHING OF LETTUCE IN TRANSCONTINENTAL SHIPMENTS

By

J. K. Stewart, horticulturist; M. J. Ceponis, plant
pathologist; and C. L. Burton, plant pathologist
Market Quality Research Division
Agricultural Research Service

SUMMARY AND CONCLUSIONS

Average load temperatures in mechanically refrigerated rail cars and trailers on flat cars (TOFC) were not appreciably affected by load pattern. But air circulation in both cars and trailers was improved by the bonded-block load pattern, as indicated by the more uniform temperatures in these loads than in the solid loads. Because of improved air circulation in the bonded-block loads, temperature variation was generally 2° or 3° F. less than in the solid loads.

Damage to the lettuce and container from crushing, however, was greater in the bonded-block load than in the conventional solid load. Also, the more open, bonded-block load reduced the number of cartons that were used in the test trailers.

In bonded-block loading somewhat more time and effort is required than in solid loading. The bonded-block pattern, in which two tiers must be loaded simultaneously, becomes more difficult to load with increasing load height. It is particularly difficult to properly place the back tier of top layers in each block.

These disadvantages outweigh the slightly improved temperatures noted in transit for the bonded-block pattern and do not justify changing from the established pattern.

INTRODUCTION

The western head lettuce industry has largely changed from using the bulge-pack carton (7306) to the level-pack carton (85-40) in an effort to reduce physical damage to the lettuce during packing and transit. As the level-pack carton is larger and thus more nearly rectangular than the other, when packed, the load is tighter, which leaves less air space between these cartons compared with the bulge-pack cartons. The tighter loads could interfere with the circulation of refrigerated air in cars and trailers, causing warm areas to develop in the load which could affect the market quality of lettuce.

These tests were conducted with the new level-pack carton to compare transit temperatures and market quality of lettuce shipped in the conventional load pattern with those in a more open load pattern.

METHODS

Test shipments were made in trailers on flat cars (TOFC) and in 50-foot mechanically refrigerated rail cars. To assure comparability, each test shipment consisted of paired cars or paired trailers in which all factors were kept as uniform as possible except for load pattern. The bonded-block load pattern was used in one car or trailer and the conventional, solid load pattern in the other.

In the bonded-block loads, cartons were stacked to provide air spaces both horizontally and vertically throughout the load (fig. 1), while in the conventional loads, the cartons were placed solidly against each other in vertical rows with no provision for air spaces. Sometimes, however, in conventional loading a limited space existed because the cartons were placed tightly against the sidewalls and the loading progressed toward the centerline where the slack, if any, would be left.

In both load patterns, cartons were usually loaded on bottoms, but in some tests, they were loaded on sides.

Figure 1 is a diagramatic drawing of the bonded-block load pattern. The actual load patterns used often differed from the theoretical pattern. For example, while most of the cartons in the tests were placed on bottoms, it was often necessary to place one row of cartons on edge adjacent to a wall to provide the proper space for either the bonded-block or solid load. Also, the top layer in the solid loads was often only a partial layer of two to four rows of cartons. These, and other slight variations in load pattern, are common in the shipment of western lettuce as the dimensions of rail equipment differ, and also, the dimensions of the cartons themselves differ slightly, depending on whether they are packed full enough to have a slight bulge.

Each unit in a paired shipment was loaded on the same day, and generally shipped to the same market. Thermostats were set at 34° F. in both cars and trailers. The shipments were made from the Salinas-Watsonville area to Chicago or to east coast markets during the lettuce season from July to October 1966.

Trailers loaded in the bonded-block pattern held an average of about 50 fewer cartons than those loaded in the conventional pattern, because of the greater air space between cartons in the bonded-block pattern. The 50-foot mechanical cars can carry the same number of cartons regardless of load pattern, because of the space left above the load. The top layer in conventional loads of lettuce is usually only a partial layer in these cars. Thus, there was space in the top layer of the bonded-block loads for the cartons that did not fit in the lower layers.

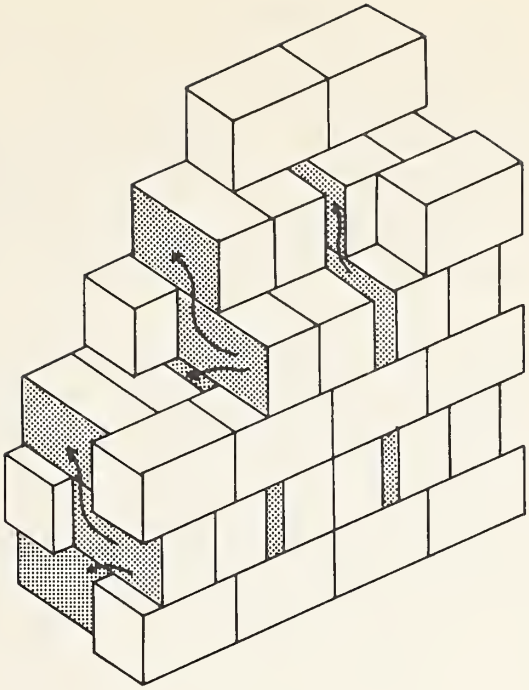

Figure 1.--Diagram of a bonded-block load pattern. The actual number of containers that can be placed crosswise and lengthwise in the load varies with the dimensions of the rail car or trailer and also varies with the dimensions of the container.

Seven test cartons containing recording thermometers were placed near the centerline in each trailer at the following locations: At the 1/3-length in the bottom and middle layers; at the 1/2-length in the bottom, middle, and top layers; and at the 3/4-length in the middle and top layers. Six test cartons containing recording thermometers were placed in the centerline of each rail car. They were at the 1/4-length of each end of the car in the bottom, middle, and top layers. In addition, recording thermometers were attached to the ceiling of the trailers at the 3/4-length, and at the ceiling of each car at the 1/4-length of one end of the car to record inside air temperatures.

At destination, the lettuce in the test cartons was evaluated for crushing and bruising by employees of the U.S. Department of Agriculture's Market Pathology Laboratories at Chicago, Ill., or at Belle Mead, N.J. Damage to the cartons in the loads was observed at destination by employees of the Department or the Railway Perishable Inspection Agency.

The crushing and bruising data were analyzed by an analysis of variance.

RESULTS

Temperatures in trailer shipments.--The average load temperature was 1° F. lower in the trailers loaded in the bonded-block pattern than in those loaded in the conventional, solid pattern (fig. 2). This was primarily because the warmest trip temperature at a single location in each trailer averaged 2° warmer in the solid than in the bonded-block loads. The average trip temperature at the coolest position in the trailers was the same, 34°, in both load patterns.

Temperatures were slightly more uniform in the bonded-block loads than in the conventional loads. Temperature variation in the two load patterns, as indicated by the difference between the coolest and the warmest positions in the load, averaged 3° F. in the bonded-block loads and 5° in the solid loads.

The coolest location in both the bonded-block and solid loads was usually in the top layer at either the 3/4- or 1/2-length. The warmest location in the solid load was usually in the middle layer at the 3/4-length. The warmest location in the bonded-block load was either in the bottom or middle layer of the load.

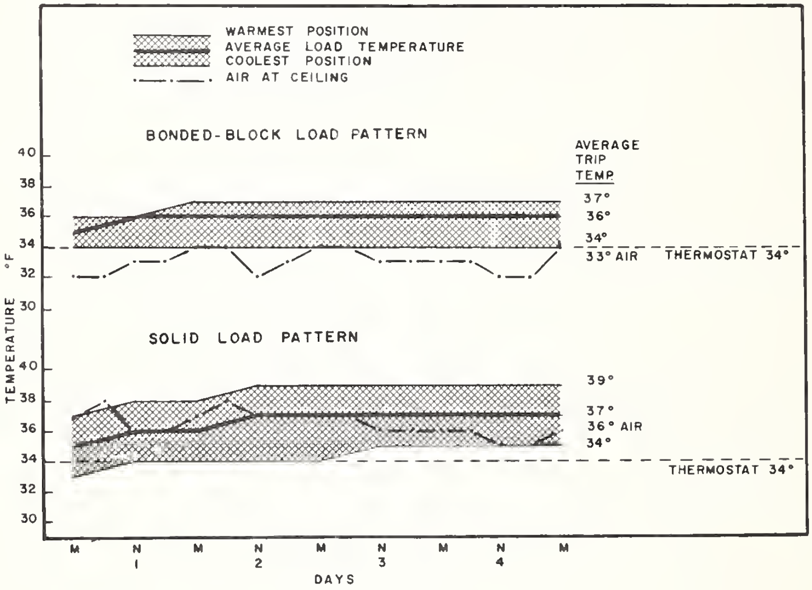

Figure 2.--Transit temperatures of lettuce shipped in trailers on flat cars (TOFC) loaded in the bonded-block and conventional, solid patterns. Temperatures for the load patterns are the averages of 3 paired shipments. Lettuce shipped from Salinas, Calif., to terminal markets.

Average load temperature in the bonded-block and solid patterns was 2° and 3° F., respectively, above the thermostat setting and 3° and 1°, respectively, above the average inside air temperature, taken at the ceiling.

Temperatures in car shipments.--Temperature relationships of bonded-block and solid loads in cars were similar to those in the trailers. In the cars, as in the trailers, the average load temperature was 1° F. lower in the bonded-block pattern than in the solid pattern (fig. 3). Also, the warmest trip temperature at a single location in each car averaged 2° warmer in the solid than in the bonded-block loads. Temperature variation in the bonded-block loads averaged 2° while that in the less open solid loads averaged 5°.

In the conventional, solid loads, the lettuce at the end of the car farthest from the refrigeration equipment, "B" end, averaged 3° warmer, 39° F., than that in the opposite "A" end of the car, 36°. Previous tests with solid loads of lettuce have also indicated that temperatures are generally warmer in the B than in the A end of mechanically refrigerated cars. In the bonded-block loads, air circulation was improved in the B end of the car so that both A and B ends averaged the same, 37°.

Average load temperatures in the bonded-block loads were 3° and in the solid loads 4° F. above the thermostat setting. Load temperatures were 3° above the air temperature at the ceiling in both load patterns.

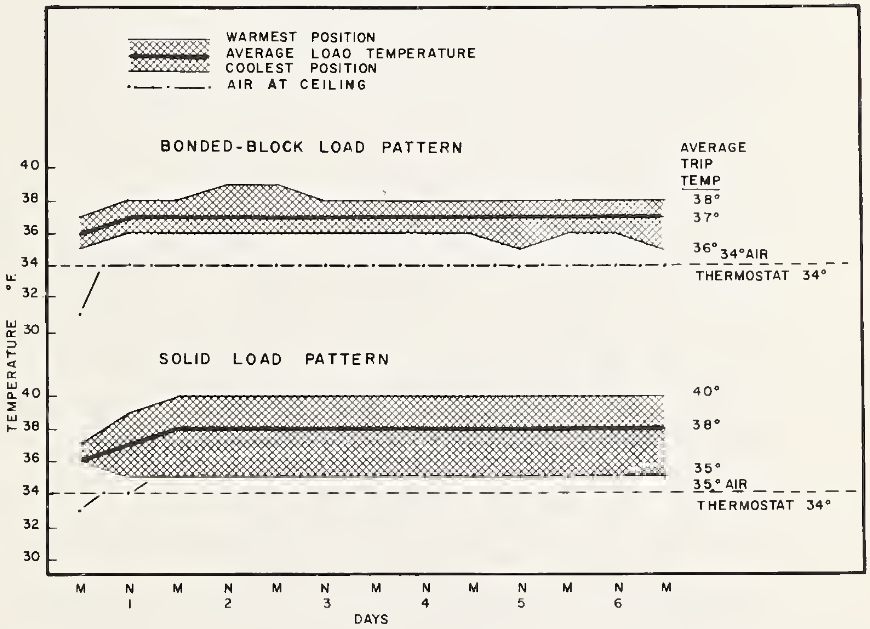

Figure 3.--Transit temperatures of lettuce shipped in 50-foot mechanically refrigerated rail cars loaded in the bonded-block and conventional, solid patterns. Temperatures for the load patterns are the averages of 3 paired shipments. Lettuce shipped from Salinas, Calif., to terminal markets.

Lettuce condition.--Moderate or severe crushing and bruising of lettuce in the test cartons were significantly greater in the bonded-block than in the solid loads (table 1). In the bonded-block loads, an average of 27.3 percent of the heads in the bottom and middle layers was moderately or severely crushed and bruised, while in the solid loads, the percentage was 18.1. The data in table 1 are for cars and trailers combined. There was no significant difference in crushing and bruising of lettuce in the two types of rail equipment. Crushing and bruising, as expected, was significantly greater in the bottom than in the middle layer of both types of loads. There was no significant interaction between load pattern and layer. The increase in physical injury to lettuce in the bottom layer compared with the middle layer was the same in both load patterns.

Container damage.--Container damage in the lower layers of the load generally appeared to be greater in the bonded-block loads than in the conventional loads. This result was indicated in destination reports by the Market Quality Research Division and also by the Railroad Perishable Inspection Agency. Data on container damage, however, were insufficient to be analyzed statistically.

Table 1.--Effect of load pattern on crushing and bruising of lettuce in the middle and bottom layers of cars and trailers shipped from Salinas, Calif., to the east coast [1]

Load pattern	Bottom layer	Middle layer
	Pct. [2]	Pct. [2]
Bonded-block- - - -	30.4	24.2
Solid- - - - - - -	21.3	15.0
	Statistical significance [3]	
Load pattern (P)- -	*	
Layer (L)- - - - -	**	
P x L- - - - - - -	NS	

[1] Data are averages of 3 paired car and 2 paired trailer shipments.

[2] Average percentage of heads with moderate or severe crushing and bruising. Each value is based on 10 cartons.

[3] NS not significant; * significant at 5-percent level; ** significant at 1-percent level.